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This is a brief technical note. It covers only one sounding rocket firing for which sufficient detailed information was available to make a comparison between theoretical and actual performance. This meager information does not warrant the publication as a NASA publication. However, potential experimenters who are likely to use the Nike-Apache should be permitted the opportunity to evaluate the results of an actual firing and establish the degree of predictability and, hence, confidence in this Sounding Rocket's performance.

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(NASA TMX-50705)

COMPARISON OF THEORETICAL WITH ACTUAL NIKE-APACHE SOUNDING ROCKET PERFORMANCE

D. W. DEMBROW AND L. B. JAMIESON

(1963) 20p

Introduction -- The Nike-Apache vehicle (see Figure 1) is a two-stage unguided sounding rocket consisting of a Nike booster for the first stage and an Apache second stage. It has been recently added to the NASA repertoire of sounding rockets and described in detail in References 1 and 2.

Nike-Apache, NASA No. 14.108 GI, was fired at Wallops Island, Virginia, on March 9, 1963. The vehicle was equipped with telemetry turnstile antennae and carried a 76 pound payload. The launcher was set at 108° azimuth and 75.7° elevation to correct for wind, the proposed launch angle being 80°.

The actual trajectory, as determined from radar plots, was compared with theoretical trajectories computed for the Nike-Apache using the given payload, weights, thrusts, and drag conditions. This comparison indicates that the effective launch angle was slightly more than 83°.

The actual trajectory was obtained by smoothing measurements from two separate radar plots. Corrections were made for the distance between the radar sites, but not for the distance from the radar sites to the launch site (about 1/2 mile). The theoretical trajectory was determined by extrapolation from a series of computed trajectories having sea level launch angles ranging from 76° to 82° in 2° intervals to obtain the 83° launch angle equivalent.

The theoretical trajectories were computed using the equations of motion applying zero-lift, no-wind conditions for a spherical, non-rotating earth -- i.e., weight, thrust, and drag. A computer program applying an n-stage two-dimensional point mass method was used on an IBM 7094 computer to compute point-by-point values of the theoretical trajectory. The following conditions applied:

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Phase 1 -- Nike Boost

Gross launch weight - 1611.5 pounds

Sea level launch

Nike burning time - 3.5 seconds

Constant thrust

Constant mass flow rate

Drag during burning (see Figure 3)

Separation at end of Nike burning

Phase 2 -- Apache Coasting

Coast for 16.5 seconds after separation

Drag during coast phase (see Figure 4)

Phase 3 -- Apache Burning

Weight at 2nd stage ignition - 293.5 pounds

Ignition 20 seconds after lift-off

Burning time - 6.4 seconds

Variable thrust (see Figure 5)

Drag during burning (see Figure 4)

Phase 4 -- Apache Coasting

Drag, same as Phase 2

Atmospheric limit - 400,000 feet ARDC 1959

Results -- The results are shown in Figure 2. It can be seen that the actual and theoretical trajectories disagree slightly. The peak altitude of the theoretical trajectory is higher than the actual by about 3 1/2 miles in about 100 miles. The results of other investigators who have computed theoretical trajectories for the Nike-Apache Sounding Rocket and their predicted

altitudes are also shown in Figure 2. The results from Reference 1 would have predicted about nine miles higher than the actual peak altitude. The results estimated from Reference 2 (when adjusted for the additional drag of turnstile antennae) would be around 20 miles higher than the actual peak altitude.

Reference 1 -- Nike-Apache Performance Handbook

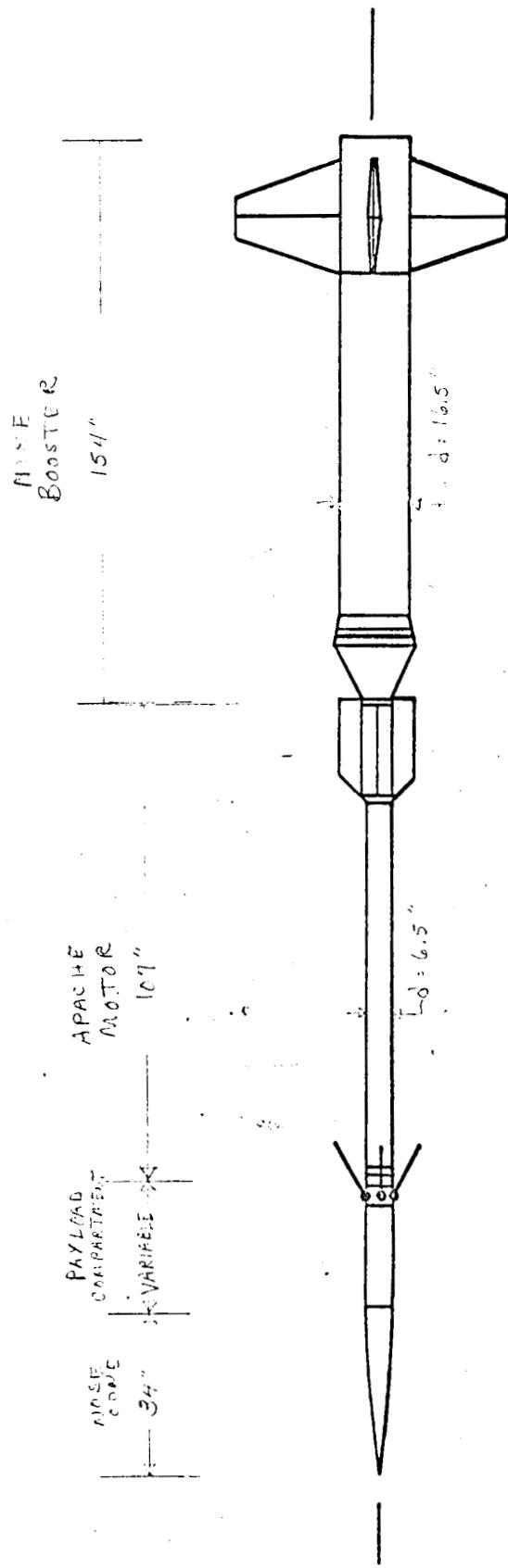
NASA GSFC X616-62-103

Reference 2 -- Performance Summary for the Nike-Apache

Sounding Rocket Vehicle

Report No. AST/E1R-00.93

Chance Vought - Under Contract NASA-1-1013



(LENGTHS - TO MEASURE INCH)

10 ft
10 ft

10 ft 10 ft

10 ft

10 ft

KΩ

10 X 10 TO THE CM. 359T-14G
KEUFFEL & ESSER CO. MADE IN U.S.A.
ALBANENE ®

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Co₂ vs Methanotrophic N₂O, burning
Fig. 2.

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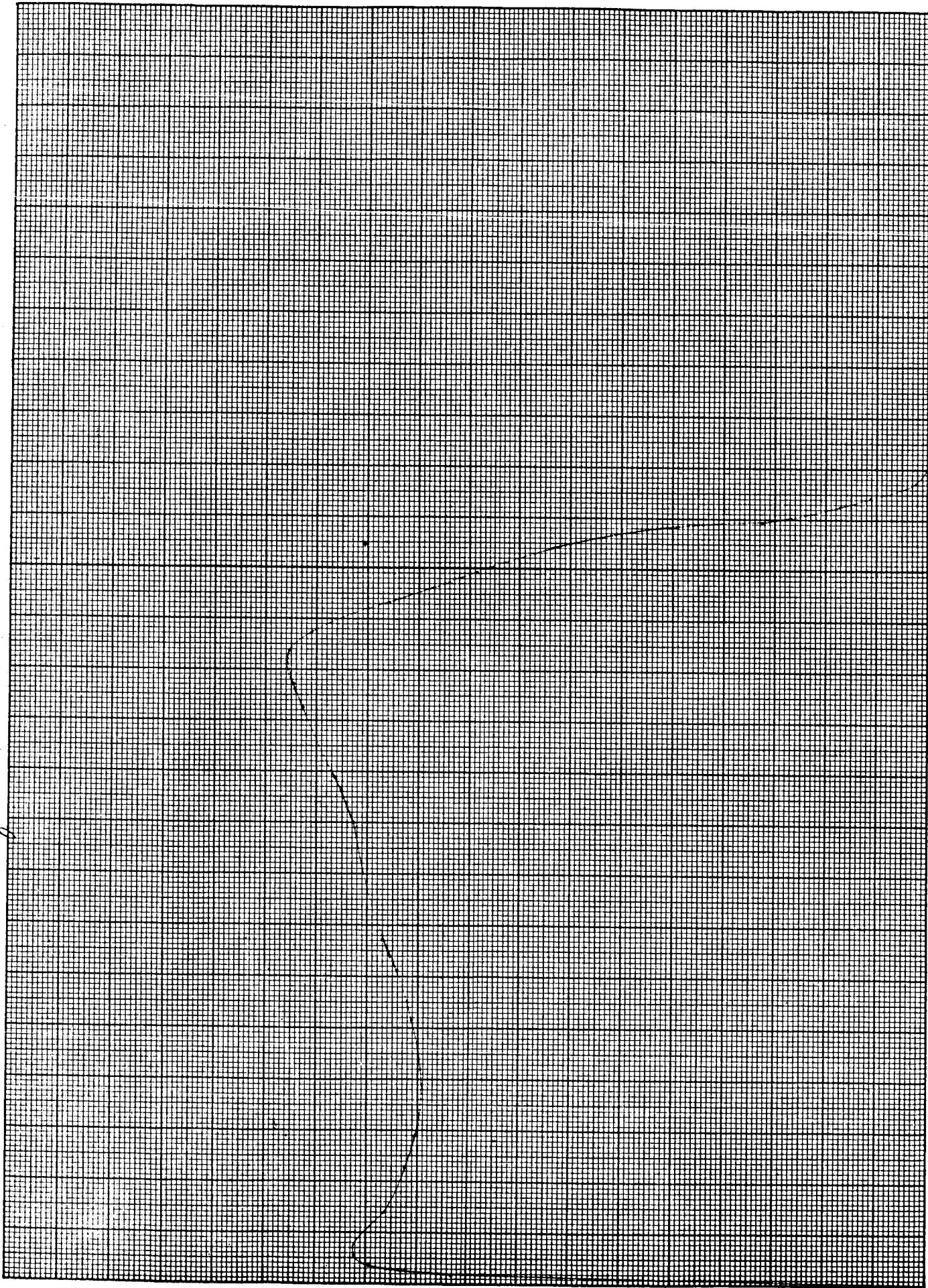
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Apache - thrust curve.

Fig. 5



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K+E 10 X 10 TO THE CM. 359T-14G
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